A GLOBAL RAPID INTEGRATED MONITORING SYSTEM FOR WATER CYCLE AND WATER RESOURCE ASSESSMENT (GLOBAL-RIMS)

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Summary

The main focus of our work was to solidify underlying data sets, the data processing tools and the modeling environment needed to perform a series of long-term global and regional hydrological simulations leading eventually to routine hydrometeorological predictions. A water and energy budget synthesis was developed for the Mississippi River Basin (Roads et al. 2003), in order to understand better what kinds of errors exist in current hydrometeorological data sets. This study is now being extended globally with a larger number of observations and model based data sets under the new NASA NEWS program. A global comparison of a number of precipitation data sets was subsequently carried out (Fekete et al. 2004) in which it was further shown that reanalysis precipitation has substantial problems, which subsequently led us to the development of a precipitation assimilation effort (Nunes and Roads 2005). We believe that with current levels of model skill in predicting precipitation that precipitation assimilation is necessary to get the appropriate land surface forcing.

1. Water and Energy Budget Synthesis

As a contribution to the World Climate Research Program's (WCRP's) Global Energy and Water-Cycle Experiment (GEWEX) Continental-scale International Project (GCIP), a pilot water and energy budget synthesis (WEBS) was developed for the period 1996-1999 from the "best available" observations and models by Roads et al. [2003]. Besides a summary paper, a companion CD-ROM [2002a] with more extensive discussion, figures, tables, and raw data is available to the interested researcher from the GEWEX project office, the GAPP project office, or the first author. An updated online version of the CD-ROM is also available at http://ecpc.ucsd.edu/gcip/webs.htm. There were a number of findings. Observations cannot adequately characterize or "close" budgets since too many fundamental processes are missing. Models that properly represent the many complicated atmospheric and near-surface interactions are also required. This preliminary synthesis therefore included a representative global general circulation model, regional climate model, and a macroscale hydrologic model as well as a global reanalysis and a regional analysis. By the qualitative agreement among the models and available observations, it did appear that we now qualitatively understand water and energy budget budgets of the Mississippi River Basin. However, there is still much quantitative uncertainty. In that regard, there did appear to be a clear advantage to using a regional analysis over a global analysis or a regional simulation over a global simulation to describe the Mississippi River Basin water and energy budgets. There also appeared to be some advantage to using a macroscale hydrologic model for at least the surface water budgets.

This phase of the project has since been extended to a study of the global land water and energy budgets, which will now take place as part of the pending NASA NEWS project.

2. Global Precipitation Comparison

Water balance calculations are becoming increasingly important for earth-system studies. Precipitation is one of the most critical input variables for such calculations since it is the immediate source of water for the land surface hydrological budget. Numerous precipitation data sets have been developed in the last two decades, but these data sets often show marked differences in their spatial and temporal distribution of this key hydrological variable. Fekete et al. (2004) compared six monthly precipitation data sets (Climate Research Unit of University of East Anglia [CRU], Willmott –Matsuura [WM], Global Precipitation Climate Center [GPCC], Global Precipitation Climatology Project [GPCP], Tropical Rainfall Measuring Mission [TRMM] and NCEP–DOE AMIP–II Reanalysis [NCEP–2]) to assess the uncertainties in these data sets and their impact on the terrestrial water balance. The six data sets tested in the present paper were climatologically averaged and compared by calculating various statistics of the differences. The climatologically averaged monthly precipitation estimates were applied as inputs to a water balance model to estimate runoff and the uncertainties in runoff arising directly from the precipitation estimates. The results of this study highlight the need for accurate precipitation inputs for water balance calculations. These results also demonstrate the need to improve precipitation estimates in arid and semi-arid regions, where slight changes in precipitation can result in dramatic changes in the runoff response due to the non-linearity of the runoff-generation processes.

3. Regional Precipitation Assimilation

Although large-scale atmospheric reanalyses are now providing physical realistic fields for many variables, precipitation remains problematic. As shown in recent studies, using a regional model to downscale the global reanalysis only marginally alleviates the precipitation simulation problems. For this reason, later generation analyses, including the recent National Centers for Environmental Prediction regional reanalysis, are using precipitation assimilation as a methodology to provide superior precipitation fields. This methodology can also be applied to regional model simulations to substantially improve the precipitation fields downscaled from global reanalysis. In particular the modified PI has now been used for models using either the Simplified (SAS) or Relaxed (RAS) Arakawa-Schubert cumulus convection parameterization schemes, over an extended-range simulation covering the beginning of the Large-Scale Biosphere-Atmosphere (LBA) wet season campaign of January 1999 over South America domain, starting on January 1st, 1999, using SAS (Nunes and Roads, 2005). As shown, rain rate assimilation not only increases the regional model precipitation simulation skill but also provides improvements in other fields influenced by the precipitation. Because of the potential impact on land surface features, we believe we will ultimately be able to show improvements in monthly to seasonal forecasts when precipitation assimilation is used to generate more accurate land surface initial conditions.

4. References

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